NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

(No. and Acre)

CODE 441

DEFINITION

An irrigation system for distribution of water directly to the plant root zone by means of surface or subsurface applicators.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes.

- To efficiently and uniformly apply water and maintain soil moisture for optimum plant growth.
- To apply chemicals.

CONDITIONS WHERE PRACTICE APPLIES

On sites where the soils and topography are suitable for irrigation and proposed plants and where a microirrigation system has been determined to be the most desirable method of irrigation.

Microirrigation systems, including subsurface drip irrigation (SDI), shall consist of bubblers (generally< 60 gal/hr), drip or trickle emitters and tapes (generally< 2 gal/hr), or spray or spinners (generally< 45 gal/hr).

Microirrigation is suited to orchard and row crops, windbreaks, greenhouse crops, and residential and commercial landscape systems and on steep slopes where other methods would cause excessive erosion or on areas where other application devices interfere with cultural operations.

CRITERIA

Planned work shall comply with all federal, state, and local laws and regulations.

The system shall be designed to uniformly apply water and/or chemicals directly to the plant root zone to maintain soil moisture within the range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

The criteria in Conservation Practice Standard 449, Irrigation Water Management, must be followed in applying this practice.

Net Depth of Water Applied. The net depth of water applied shall be sufficient to maintain stress in the plant within acceptable limits. The net depth of water applied shall be expressed as inches per day per unit of design area. The following formula is a method to determine the net depth of water applied.

$$F_n = 1.604 \frac{QNTE}{AF}$$

Where: F_n = net application depth expressed as in/day/design area,

1.604 = units conversion constant derived by dividing 231 cubic inches per gallon by 144 square inches per square foot,

Q = discharge rate, gal/hr/emitter,

N = number of orifices or emitters,

T= hours of operation per day,

E = field application efficiency, expressed as a decimal,

A = ft^2 of field area served by N (number of emitters), and

F = the design area as a percentage of the field area, expressed as a decimal.

Applications shall include adequate water for leaching in order to maintain a steady state salt balance.

System Capacity. The minimum system capacity shall be adequate to deliver the average daily water requirement during the peak use month in not more than 18 hours of operation.

The system design capacity shall be adequate to meet the intended water demands during the peak use month for all plants planned to be irrigated in the design area. Design capacity shall include an allowance for reasonable water losses (evaporation, runoff, leaching

requirements, and deep percolation).

The rationale for using a design capacity less than the peak daily irrigation water requirement shall be fully explained and agreed upon by the end user. Field application efficiency (E) for design purposes shall not exceed 90 percent.

The following formula is a method to determine the system design flow rate:

$$G = 0.623 \times A \times C \times N / E$$

Where: G = Gallons / Day / Plant,

0.623 = units conversion constant derived by dividing 144 square inches per square foot by 231 cubic inches per gallon,

A = Area (sq. ft.) to be irrigated per plant. "A" shall not be less than 0.33 of the plant allocated area for row crops, vineyards, and orchards. "A" shall not be lass than 0.25 of the plant allocated area for windbreaks,

C = Appropriate use rate – inches / day,

N = Number of plants, and

E = Expected system efficiency expressed as a decimal (0.90 Maximum).

Where natural precipitation and/or stored soil water is not sufficient for germination, special provisions shall be made for germination, or the microirrigation system shall apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. The depth of a subsurface system for use on annual crops shall be limited by the ability of the system to germinate the seeds, unless it is stated in writing that other provisions will be made for this function.

Emitter Discharge Rate. The design discharge rate of applicators shall be determined from manufacturer's data for the expected operating pressure. The discharge rate shall not create runoff away from the immediate application area. A basin beneath the plant canopy is required for water control for bubbler irrigation, with bubblers confined to the basin area.

Number and Spacing of Emitters. The number and spacing of emitters along the lateral line shall be adequate to provide water distribution to the plant root zone and percent plant wetted area (P_w). National Engineering Handbook (NEH), Section 15, Chapter 7-22, shall be used to determine the P_w.

Emission Uniformity. An emission uniformity of 75% is the minimum allowable following procedures outlined in the "Drip Irrigation Chapter" of the New Mexico Irrigation Guide.

Operating Pressure. The design operating pressure shall be in accordance with manufacturer recommendations. The system operating pressure must compensate for pressure losses through system components and field elevation effects.

Emitter Manufacturing Variability. The manufacturer's coefficient of variation (C_V) shall be less than 0.07 for point source emitters and less than 0.20 for line source emitters.

Allowable Pressure Variations.

Manifold and Lateral Lines. Manifold and lateral lines, operating at the design pressure, shall be designed to provide discharge to any applicator in an irrigation sub-unit operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate. Pressure shall conform to manufacturer's recommendations.

Main and Sub-Main Lines. Main and sub-main lines shall be designed to supply water to all manifold and lateral lines at a flow rate and pressure not less than the minimum design requirements of each subunit. Adequate pressure shall be provided to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.). Pipe sizes for mains and sub-mains shall maintain flow velocities and emission uniformity (EU) within recommended limits as determined by procedures contained in NEH Section 15, Chapter 7.

Economic considerations shall include both installation and operating costs. Main and sub-main lines shall be designed and installed according to the appropriate NRCS Conservation Practice Standard Code 430, Irrigation Water Conveyance, Pipeline, in the NRCS FOTG, Section IV.

Filters. An appropriate filtration system (filter element, screen, strainer, settling pond and/or

filtration) shall be provided at the system inlet. Under clean conditions, filters shall be designed for a head loss of 5 psi or less.

The filter shall be sized to prevent the passage of solids in sizes or quantities that might obstruct the emitter openings. Filtration systems shall remove all solids larger than one-fourth the emitter opening diameter or the emitter manufacturer's recommendations, whichever is more stringent.

The filter system shall provide sufficient filtering capacity so that backwash time does not exceed 10% of the system operation time. Within this 10% time period, the pressure loss across the filter shall remain within the manufacturer's specification and not cause unacceptable EU.

Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0% of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter.

Pressure Regulators. Pressure regulators shall be used where topography and the type of applicator dictate their use. Pressure regulators shall not be planned to compensate for improperly designed pipelines.

Chemical Water Treatment. Maintenance and water treatment shall be used to prevent clogging based upon dripper and water quality characteristics. ASAE EP405.1 contains guidelines for chemical water treatment.

The irrigation water supply shall be tested to determine feasibility and treatment needed for use in microirrigation systems.

System Flushing. Appropriate fittings shall be installed above ground at the ends of all mains, sub-mains, and laterals to facilitate flushing. A minimum flow velocity of 1 ft/sec is considered adequate for flushing.

Subsurface Irrigation. Tubing depth and spacing are soil and crop dependent. Emitter line depth shall consider the auxiliary irrigation methods used for leaching, germination, and initial development. Maximum lateral line distance from the crop row shall be 24 inches for annual row crops and 48 inches for vineyard and orchard crops. EU shall be designed for a minimum of 85 percent.

Water flow in the drip line shall be level to 2 percent downgrade with a maximum length of 660 feet. If these conditions are not met, the design shall be supported by engineering (hydraulic) documentation that show EU of 85 percent or greater.

Chemigation. System EU shall not be less than 85 percent where fertilizer or pesticides are applied through the system.

Injectors (chemical, fertilizer, or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit placed in accordance with manufacturer's recommendation and includes integrated back flow-prevention protection.

Chemigation shall be accomplished within the length of time needed to deliver the chemicals and flush the pipelines. Application amounts shall be limited to the amount necessary, as recommended by the chemical label.

On systems where chemicals are injected, care shall be taken so the injected nutrients do not react with other chemicals in the irrigation water to cause precipitation and plugging.

CONSIDERATIONS

Water quality is usually the most important consideration when determining whether a microirrigation system is feasible. Water often contains high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand.

Microirrigation can influence the movement of dissolved substances below the root zone, which could affect groundwater quality.

Pest or nutrient management planning should address the timing and rate of chemical applications.

Field shape and slope frequently dictate the most economical lateral direction. Whenever possible, laterals should be laid downslope on slopes no greater than 2 %.

DRAWINGS AND SPECIFICATIONS

Drawings and specifications for the microirrigation system shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan

shall provide specific instructions for operating and maintaining the system to ensure that it functions properly, including reference to periodic inspections and the prompt repair or replacement of damaged components. Typical maintenance items include:

- Clean or backflush filters when needed.
- Flush lateral lines regularly.
- Check applicator discharge often; replace applicators as necessary.
- Check operating pressures often. A pressure drop (or rise) may indicate problems.
- Check pressure gauges to ensure proper operation; repair/replace damaged gauges.
- Check for leaks on particularly along lateral lines.
- Inject chemicals as required to prevent precipitate buildup and algae growth.
- Check chemical injection equipment regularly to ensure it is operating properly.
- Check and assure proper operation of back-flow protection devices.

REFERENCES

National Engineering Handbook, Section 15, Chapter 7.

“Drip Irrigation Chapter” of the New Mexico Irrigation Guide.

NRCS FOTG, Section IV, Code 430.

NRCS FOTG, Section IV, Code 449.

ASAE EP405.1

National Engineering Handbook, Part 652, Irrigation Guide